ENTOMOLOGY SERIES — BULLETIN No. 13

Agricultural College & Research Institute in Mysore,
HEBBAL, BANGALORE

The Major Pod-Borer (Adisura Atkinsoni, M) of Dolichos Lab-Lab (Avare).

BY

B. KRISHNAMURTI, B.SC., F.R.E.S.,
Government Entomologist,

AND

M. APPANNA, B.SC.,
Assistant Entomologist.

BANGALORE:
PRINTED BY THE SUPERINTENDENT AT THE GOVT. PRESS
1948

THE MAJOR POD-BORER (ADISURA ATKINSONI, M.) OF DOLICHOS LAB-LAB (AVARE).

Introduction.—Of the various pulses grown in Mysore State, Dolichos lab-lab covers the largest acreage. It is grown practically all over the State ; there is seen a much larger acreage under this crop in the southern and western parts of the State than in other regions. This crop is infested by several pod-borers, namely, (1) Adisura atkinsoni, M. ; (2) Exelastes atomosa, W. ; (3) Heliothes armigera, F. ; (4) Maruca testulalis, G. Of these Adisura atkinsoni, M., is the major and the most serious causing heavy damage to the crop. This insect has had comparatively little attention paid to it by investigators. An attempt has now been made in this publication to disclose, in a somewhat exhaustive manner, its characteristic structural and biological features and indicate the possibilities of its biological control, by means of its commonly occurring and easily handled indigenous beneficial parasite.

Occurrence and Distribution.—The appearance of this insect in the field generally synchronises with the appearance of flower spikes on the crop. The time of appearance of the first flush of flowers being variable in different parts of the State, the exact date of first emergence of the insect also varies ; however the pest may be stated to, generally, make its appearance, in all the areas in the State, where lab-lab is grown, by about the middle of October and gradually disappear in the period between the middle of January and early part of February, when the crop is also at the final stage of its life. Thus this pod-borer is a seasonal pest appearing (annually) only during the particular reproductive season of the crop in the State.

Nature of Damage.—The pod-borer-caterpillar, after hatching out from the egg, wanders about, over the set blossoms, tender pods and even half-mature pods for a short while before actually boring inside them. Infected pods, when cut open, reveal the seeds in several stages of damage—some only nibbled at, some partly cut up and eaten and some almost completely eaten away. Generally an infected pod can be made out by the presence of one

or more holes made on the blossoms or pods by the caterpillar, the diameter of the hole varying from less than the size of a pin-head to about 1/8 inch or more depending on the stage of development of the caterpillar attacking the pod. In cases, where the attack is fresh, small pellets of excreta of the caterpillar are seen on the outer fringe of the holes on surface of the pods.

Extent of Damage.—The extent of damage caused by this pest is very variable from season to season. Random collections of pods were made at the peak period of the pest during the season from several areas during the past three years; and the details of data are indicated in the table :—

TABLE I.

Table showing the percentage of natural infestation in the following areas during different seasons.

Locality	Season				
	1943-44	1944-45	1945 46	1946-47	1947-48
Agrahar ...	40	38	27	58	47
Puttiyanapalya ...	37	26	31	71	45
Sarakki ...	34	31	21	61	33
R. Guttahalli ...	12	18	24	Not collected	...
Hebbal (Kempapura)	17	24	28	82	17.8
Gangordanahalli ...	Not collected	22	16	Not collected	41
Average ...	28	26·5	24·5	68	36·7

Since the pods and the beans are made use of, both when fresh and green and when dry, the presence of infested or damaged pods and beans in any lot considerably reduces the market value of the commodity.

It is observed that the borer caterpillars are not always found in all the infected and damaged pods; since they have the habit of infecting more than one pod and keep migrating from pod to pod, in any infected field, it is quite common to find a mixture of infected pods some with borers and others without them.

Influence of Weather Conditions.—A combination of comparatively high humidity of the North-east Monsoon

season and heavy rainfall—heavy mist in the morning and bright sunshine during the day—appears to be very favourable for the normal appearance, multiplication and optimum activity of the adult moths and the borer caterpillars. It is observed that failure of the monsoon and even a poor monsoon acts adversely on the emergence of adult moths early in the season and large numbers of pupæ, of the previous season, in the soil get dessicated and a number of moths even after eclosion from many pupæ fail to travel upwards to the surface successfully.

TABLE II.

Table showing the monthly average Humidity and monthly total Rainfall during the season of the Crop.

Year	October				November			
	Humidity			Rainfall	Humidity			Rainfall
	8 hrs	12-30 hrs.	17 hrs.		8 hrs.	12-30 hrs	17 hrs.	
1	2	3	4	5	6	7	8	9
1943 ...	90	70	70	1·4	86	57	60	0 07
1944 ...	90	63	61	2·27	88	65	68	0·13
1945 ...	83	53	52	0·14	81	53	52	0·05
1946 ...	90	62	61	5 11	91	69	71	6 26
1947 ...	86	41	54	8.14	77	44	66	0·18

Year	December				January (following year)				Total rainfall for the season
	Humidity			Rainfall	Humidity			Rainfall	
	8 hrs.	12-30 hrs.	17 hrs.		8 hrs.	12-30 hrs.	17 hrs.		
	10	11	12	13	14	15	16	17	18
1943 ...	84	49	51	...	85	42	37	...	1·47
1944 ...	87	50	51	0·02	82	40	35	...	2·42
1945 ...	75	41	33	...	75	28	25	...	0·19
1946 ...	89	64	66	2·20	87	51	48	0·13	13·7
1947 ...	84	47	43	0·26	85	46	43	0·42	9·70

The tables 1 and 2 indicate in addition a comparatively increased percentage of incidence of the pest in 1947-48 season as compared to the incidence in the previous years, (except 1946-47 season). This is again probably mainly due to heavy rainfall during October

1947 which favoured a larger emergence of the moths and further multiplication of the pest.

General Life History.—Being a specific pest of a seasonal crop, this insect makes its appearance just at the time when conditions are well suited for rapid feeding and development. Adult moths commence to emerge generally by about the middle of October from the pupæ of the previous season formed inside the soil. Egg-laying takes place shortly after the adults mate. The young caterpillars hatching out of the eggs attack the flower buds, tender and half-mature pods. They grow as they feed and pass through six moults before pupating in the soil. The moths emerge out about 15—16 days after pupation. The complete life-cycle of the insect occupies a period of about 44 days. During the season the insect generally passes two generations and the third generation caterpillars pupate in the soil and remain as such till the next season of the crop.

In an infested field, the insect is seen in all its stages of development. This is because the moths do not emerge at one and the same time in any given locality. Hence eggs are laid continually at varying intervals.

The following table gives the details of developmental periods of the insect :—

TABLE III.

Statement showing development period of lab-lab (Avare) pod-borer (Adisura atkinsoni, M.).

Date eggs laid	Date larvæ hatched	Moulted on	Moulted on	Moulted on
1	2	3	4	5
17-11-45	22-11-45	24-11-45	27-11-45	29-11-45
,,	,,	,,	,,	,,
,,	24-11-45	27-11-45	29-11-45	5-12-45
,,	,,	,,	4-12-45	7-12-45
,,	,,	,,	1-12-45	5-12-45
,,	,,	29-11-45	4-12-45	7-12-45
,,	,,	27-11-45	30-11-45	4-12-45
,,	,,	,,	29-11-45	,,
,,	,,	,,	30-11-45	3-12-45
,,	,,	,,	29-11-45	,,
,,	,,	,,	29-11-45	4-12-45

Moulted on	Moulted on	pupated on	Moth emerged on	Total period of development
6	7	8	9	10
3-12-45	11-12-45	16-12-45	1-1-46	45 days
4-12-45	10-12-45	15-12-45	2-1-46	46 ,,
10-12-45	15-12-45	20-12-45	3-1-46	45 ,,
12-12-45	17-12-45	21-12-45	,,	45 ,,
9-12-45	15-12-45	20-12-45	1-1-46	43 ,,
11-12-45	12-12-45	,,	1-1-46	43 ,,
,,	15-12-45	17-12-45	1-1-46	43 ,,
10-12-45	,,	,,	2-1-46	44 ,,
8-12-45	11-12-45	15-12-45	Not yet emerged	Pupæ found inside the soil.
,,	10-12-45	,,	,,	
10-12-45	12-12-45	16-12-45	,,	

Description of the various stages of the insect—Adult.— The adult is a somewhat stout, medium-sized, ochreous brown moth[1] with[1] well-developed head and comparatively short, slender and whiplike antennae. The thorax has a slight hump and is covered over by a light brown fluffy mass of scales. The abdomen is proportionately stout and generally tapers towards the posterior end. In the female the tip of the abdomen is more obtuse than in the male. Except for the more obtuse-pointed abdomen in the case of the female than in the male, there is no other external morphological character which readily distinguishes one sex from the other. The wings are short and broad with light dark brown wavy markings on the forewings. The wings as well as the legs are also thickly covered over by scales. The moth rests with the wings folded along the central longitudinal axis of its body.

The moth is usally sluggish but is capable of short flights when disturbed. It shuns light and is essentially nocturnal in habit. During daytime it is seen resting on the under surface of the leaves or on the lower regions of the stem covered over by the bush. In captivity the adults, which were fed on honey, lived for a period of three or four days.

There is not seen any preponderance in population of one sex over the other. In any lot of emergence it was seen that the sexes were almost equal. Mating of individuals has not been observed in the field. In captivity it takes place under cover. The adults remain separate in bright light even in small enclosures.

Egg-laying and Egg.—The fertilized female lays eggs mostly on tender leaves, flower buds and pods. Tender leaves are preferred only when flower buds or pods are not found. The eggs are probably laid in the field during either late in the evening or early morning hours. In the cages eggs were at no time laid during mid-day. Each female moth lays nearly 150 to 180 eggs. A fully gravid female, when cut open, revealed a maximum of 198 eggs. Each female moth oviposited over a period of two or three days in the laboratory (during the life-time of the adult).

The egg is spherical in shape and creamy white in colour. It is smooth and fairly opaque and is about one-fourth the size of 'cuscus.' It is easily and clearly seen with the naked eye being quite conspicuous on the green pods; when laid on the flower blossom, it is much less conspicuous. The female deposits eggs in a detached manner and singly, the eggs being glued on to the surface on which they are laid. It is a common sight to see numbers of eggs being irregularly placed together near one another on a single pod. The colour of the egg changes from opaque white to dark brown about 72 hours after it is laid.

Newly Emerged Larva. (First Instar Larva.)—The larva (Caterpillar) hatches out in about four days after the egg is laid. It emerges out by biting through the egg-shell just to a side of the free end (Micropylar end) of the egg. Empty egg cases from which larvæ have emerged out are usually seen in numbers in the same places where the eggs were laid. The newly hatched larva possesses a dark head. Small saetal hairs are present all over the body. The larva, after a short interval during which it wanders about, bores into the flower bud or pod. When dislodged, it hangs by a silken thread. It attains a maximum length of 5 mm.—6 mm. before it moults for the first time.

Second Instar Larva.—In this stage the colour of the body of the larva is greenish-white. Short hairs are present on the body surface. It possesses a chitinous head with powerful biting mouthparts. The larva generally feeds on the seeds remaining entirely inside the pods and thus completely hidden from view from outside. It attains a length of 8 mm.—10 mm. and then goes through the second moult.

Third Instar Larva.—The colour of the body is greenish-white. Two small (thin) white bands are seen one on either side of the body more towards the ventral aspect of the body. The body surface is almost smooth except for the presence of few hairs on the penultimate abdominal segments. The larva grows to a size of 12 mm. to 16 mm. in length and there is seen a corresponding increase in girth. It moults in two or three days.

Fourth Instar Larva.—The larva possesses a uniform green colour with light dark green lines on either sides of the mid-dorsal line. The white streaks on either side of the body are well developed. Just to the dorsal aspects of these streaks are seen faint brown markings. The prolegs are better developed than in previous stages. There is seen a perceptible increase in the activity of the larva. While in the previous instars the larva feeds remaining inside the pods, in this stage the larva gets out and bores into other fresh pods, feeds on the seeds inside but having at least about 2/3 of its posterior portion of its body on the outside. The larva grows to a length of 18 mm.—20 mm. before it moults.

Fifth Instar Larva.—The larva is comparatively more active and does greater damage to the seeds in the pods. The brown markings on the sides of the body are well pronounced. The larva increases in girth and grows to a maximum length of 27 mm. to 28 mm.

Sixth Instar Larva.—The body is greenish in colour. The white streaks are well developed, as also the brown markings. Unlike the white streaks, these brown markings do not unite with one another and form a continuous band on individual segments. On the last three segments these markings are more or less united together and appear as two 'eye-spots' with short projections posteriorly. The head is brownish green being rarely dark brown in colour. The five pairs of prolegs are well developed. Of these the last pair of prolegs is used as claspers to hold the pods on the outside while the larva feeds within on the seeds. The larva grows to a size of 33 mm. to 36 mm. in length and slightly more than 1/8 inch in girth. There is seen a great variation in the colour of the later stages of the larva depending on the nature of food available. Especially in the third generation, brownish-green coloured larva are met with in larger numbers than in the earlier generations. The larvæ display cannibalistic tendencies in cages with large numbers of them within.

This stage larva feeds voraciously. After feeding for four or five days, it remains quiescent for sometime and then enters the soil to pupate. It goes through the final moult before pupation.

Moulting.—During the process of moulting the body integument ruptures along the mid-dorsal line. The moulted head capsule is the only remnant of the moulted skin that is usually found after each moult. In the last moult, prior to pupation, the complete moulted skin is seen attached to the posterior end of the future puparium.

The caterpillar emerging out of the old integument is at first uniformly greenish in colour. Gradually the white streaks make their appearance. About 7—8 hours after moulting, the characteristic brown markings appear on the lateral portions of the abdominal segments. These markings are less pronounced in the earlier instars than in the full grown larva.

Pupation and Pupa.—Pupation takes place under the soil. Prior to pupation the larva gradually shrinks in length and undergoes a moult. In the field, pupæ are found occasionally in an earthen cocoon. In individual receptacles the larvae successfully pupate even in the absence of soil.

The pupa is brown in colour, and is about $\frac{1}{2}$ inch in length. It is broad anteriorly and gradually tapers to the posterior end. It is a typical noctuid pupa. When it is disturbed the abdominal region moves while the anterior cephalo-thoracic region remains motionless. The pupal period varies from 15 to 18 days in the first two generations to over nine months in the last generation of the insect.

The pupæ are generally found about three to four inches below the surface of the soil. In a series of trials in the laboratory, pupæ were placed at different depths—ranging from 3 inches to 12 inches in the soil. The soil used was of the red gravelly type found in the avare fields round about Bangalore. It was observed that adults did not emerge from pupæ kept seven inches below the surface of the soil. The moths had developed but failed to emerge out by pushing themselves to the ground level.

It was observed that all the pupæ of the previous season did not transform themselves as adults

To get an approximate idea of the percentage of successful emergence of moths, under controlled conditions, pupæ were placed in field cages in the laboratory within

a depth of 4 inches below the surface of the soil. In order to somewhat simulate the natural conditions, water was sprayed lightly on the soil inside the cages on the days following those on which it rained in the fields in the surrounding areas. It was observed that from only about 20·5 per cent of the pupæ, moths emerged; that 58·8 per cent of the pupæ had deteriorated completely and that in the remaining 20·7 per cent the adults had developed but failed to emerge.

But in considering the percentage of successful emergence of moths in the field, one should not lose sight of the several factors—ploughing of the field and exposing the pupæ to attack by natural enemies such as birds, ants, lizards, etc.,—that contribute to the death or decay or destruction of the pupæ. A conservative estimate of successful emergence of the moths in the field from the pupæ of the previous season may vary between 2 per cent to 5 per cent. This figure is not deduced from any data collected in the field but is only an inference drawn from general observations made.

Control.—Several methods were tested to attract adult moths by exposing in avare fields, late in the evenings and nights, during the season, baits of sugar syrup to which different types of essential oils were added[3]. Fresh and fermented molasses with and without amyl acetate were also tested. The results were at no time either encouraging or conclusive.

Deep-ploughing of the land where avare is grown can be practised with advantage. By adopting this method of control, the pupæ of the previous season are exposed to the sun, and the other natural enemies—birds, lizards, ants, etc., and are thus destroyed. Thereby the incidence of the pest may be greatly reduced in the first generation of the insect. But it may be mentioned here that this method of control, even if practised exclusively does not eradicate the pest. Although by itself, this method of control gives good results, better results of control can be achieved by adopting in addition to this cultural method, the other method of mechanical control—dislodging or rubbing off the eggs (and early hatched larvæ) found on the pods. This latter operation has to be carried out for several days at a stretch in any locality since the moths emerge almost continually in the field and lay eggs as they emerge. Village children, with a little training, will carry out this operation with delight and enthusiasm. This

method of control has often been demonstrated and put into operation in private avare fields and very satisfactory results have been obtained. With a little care this operation can be easily carried out in the field by the children and others without trampling on the ragi crop standing in the field.

A series of trials with D. D. T. spray powder and Gammexane D. 025, as dusts, were made. D. D. T. spray powder (Geigy) was diluted with equal quantity of chalk powder and Gammexane D. 025 was used at 10 per cent strength, the diluent in this case also being fine chalk powder.

These chemicals were dusted just when the first batch of eggs were noticed. 2 gunta plots were dusted and for each chemical there were three replications with the same number of control. The first pick of mature pods was done 23 days after the first dusting. A second dusting was done 33 days after the first dust. The second pick of mature pods was done 35 days from the date of first dusting.

To get an idea of the percentage of natural infestation in the field, collections were made at random in a plot a little farther away from the experimental plot and the same was found to be 17·9. The low percentage of infestation recorded in the controls is probably due to the odour of the chemicals dispersing from the experimental to the control plots at the time of dusting and before egg-laying. There is seen a perceptible decrease in the percentage of infestation in the treated plots as compared with the controls. 50 per cent D. D. T. spray powder seems to give better degree of control than 10 per cent Gammexane D. 025.

TABLE IV.

Table showing the percentage of infestation in the treated and control lab-lab plots at Hebbal Farm.

Plot No.	First Pick		Second Pick	
	Total Weight of pods picked	Percentage of infestation	Total Weight of pods picked	Percentage of infestation
	lbs.		lbs.	
1	23	1·8	16	1·5
2	60	1·75	16	1·0
3	33	3·3	8	2·25
4	38	1·48	16	1·8
5	42	2·0	21	1·1
6	43	3·75	15	7·25
7	42	1·5	31	1·5
8	28	9·0	6	3·1
9	29	6·87	13	2·2

N. B.—Plot Nos.—1, 5, 9 were dusted with 10 per cent Gammexane D. 025 (I.C.I.)
2, 4, 7 were dusted with 50 per cent D. D. T. Spray powder (Geigy)
3, 6, 8 were untreated and served as controls.

Biological.—The larva is subject to attack by an ectophagus parasite (Microbracon brevicornis-Braconidæ-Hymenoptera) in nature. Random collections of infested pods were made in different localities during the past four seasons. The following table gives the data collected regarding the percentage of natural parasitisation in nature.

TABLE V.

Locality	Season				
	1943–44	1944–45	1945–46	1946–47*	1947–48
Agrahar ...	10	6	12	Nil	10
Puttianapalya ...	14	17	11	„	8
Sarakki ...	28	21	6	„	7
R. Guttahalli ...	28	12	2	Not collected	...
Hebbal ...	21	19	14	Nil	12
Gangerdanahalli ...	Not collected	11	7	Not collected	6
Average ...	20	14·3	8·6	...	8·6

*The effect of adverse weather conditions, as stated in the text, was telling on the population or even emergence of the parasite.

Table VI.

Table showing the monthly average Humidity and monthly total Rainfall during the season of the Crop.

Year	October				November			
	Humidity			Rainfall	Humidity			Rainfall
	8 hrs	12-30 hrs	17 hrs		8 hrs	12-30 hrs	17 hrs	
1943 ...	90	70	70	1·4	86	57	60	0·07
1944 ...	90	63	61	2·27	88	68	68	0·13
1945 ...	83	53	52	0·14	81	53	52	0·05
1946 ...	90	62	61	5·11	91	69	71	6·26
1947 ...	86	58	54	8·14	77	44	66	0·68

Year	December				January (following Year)				Total Rainfall for the season
	Humidity			Rainfall	Humidity			Rainfall	
	8 hrs	12-30 hrs	17 hrs		8 hrs	1 -30 hrs	17 hrs		
1943 ...	84	49	51	...	85	42	37	...	1·47
1944 ...	87	50	51	0·02	82	40	35	...	3·42
1945 ...	75	41	39	...	76	28	25	...	0·19
1946 ...	89	64	66	2·20	87	51	48	0·13	13·7
1947 ...	84	47	43	0.28	86	46	43	0·42	9·70

While the weather conditions, which favour the maximum incidence and activity of the host (the pod-borer larva and moth), generally also favoured the normal appearance and development and activity of the parasite in the field, it was observed that heavy rainfall and high humidity during the season of the crop retarded the activity of the parasite in the field while they increased the activity of the pest. In fact, under such conditions very few natural parasites emerged even in the laboratory from collections made in various localities.

The adult parasite is a medium-sized brown coloured insect having a clearly distinguishing dark brown patch on the dorsal surface of the abdomen between the 4th and 8th segments.

Though naked larvæ are seen to be parasitised, the adult parasite has a tendency and even shows a decided preference for larvæ which are either completely or partially inside the pods. Usually larvæ of 3rd moult and later stages are parasitised. The larvæ do not show any signs

of wriggling or other visible reaction when the parasite stings. Observations made in the laboratory show that the parasite remains stinging the larva continuously for a period of 3 to 4 minutes at a time.

The parasite eggs are creamy white in colour and spindle shaped. They are laid externally on the body surface usually in the intersegmental regions of the host larva. The grubs hatch out in about 3-4 days. They are greenish-white to dirty-white in colour, the colour of the parasite grubs depending on the colour of the host larva. The grubs pupate, after 10 to 12 days, in whitish cocoons either inside or outside the pods. In the case of cocoons found inside the pods, the adult parasites emerge and escape from the pod through the hole previously cut by the host larva. The maximum number of pupæ found on one host larva is 8.

The total period of development of the parasite varies from 12 to 25 days. Usually the adult parasites emerge in large numbers in about 15 to 18 days.

The number of males and females that emerge from any one lot is almost equal. The following gives the number of parasites that emerged from the lots noted below :—

	Males	*Females*
Lot A	... 47	... 47
Lot B	... 47	... 52
Lot C	... 30	... 33
Lot D	... 18	... 25

The adults lived for a period of about 3 to 8 days in the laboratory cultures.

The authors[2] carried out a series of trials in the laboratory and later in the field, utilising another allied parasite—Microbracon hebetor, S., the ectophagous larval parasite of Corcyra cephalonica, St., the common moth-pest of stored rice, jowar and flour-against the pod-borer of avare in question. In most of the several cultures set up in the laboratory with particular instars of laboratory-bred pod-borers and subjected to the attack of freshly emerged individuals of Microbracon hebetor, S., the host was readily stung and eggs were deposited by the females. The grubs hatching out from the eggs fed on the caterpillar-host and pupated and adult parasites emerged out in due course. The complete life-cycle spread over a period of 16 to 28 days. Large number of parasites usually emerged in about 16 to 18 days. The maximum number of pupæ

found on one host larva, in the laboratory cultures, was 13. Not only fully exposed and free host larvæ but also those that were found inside Lab-lab pods in different cultures were freely parasitised, the female parasites even penetrating easily, through punctures, inside pods.

Similar observations were made, also, in the case of cloth cages enclosing only infested pod-bearing branches of lab-lab, and other cages fixed in the soil enclosing whole bushes into which suitable numbers of parasites were introduced.

In the laboratory cultures set up with laboratory-bred host larvæ and exposed to the attack by both Microbracon brevicornis (Natural and Specific) and Microbracon hebetor (alternate) parasites, the host larvæ were not only successfully parasitised but also both species of parasites emerged in one and the same culture. But both the natural and introduced parasites usually preferred altogether separate hosts and in only a very few instances was the same host parasitised by both the parasites.

Bulk releases of Microbracon hebetor, S., in selected plots (with proper controls) of borer-infected lab-lab, in the field were also made at the Hebbal Farm.

A small field containing avare interplanted with cotton was selected. The whole field was divided into three plots, each plot containing 582 bushes. Before the the release of parasites, care was taken to see that host larvæ in advanced stages of development were present in sufficient numbers.

Parasites were released at intervals of about 10-12 days in plot A. They were released in batches of 100 in three or four places. Plot B acted as buffer and plot C served as check. During the season five releases of parasites were made (mostly from December onwards). Infested pods were picked from the plots at intervals of 5 or 6 days from the date of first release. In all eight picks were made and the following table gives the data collected.

TABLE VII.

Statement showing the results of the examination of the several pickings in the experimental plots and plot D at Hebbal Farm.

No. of pick.	No. of infested pods	Plot A		Plot B		Plot C		Plot D	
		Healthy larvae	Parasitised larvae	Healthy larvae	Parasitised larvae	Healthy larvae	Parasitised larvae	Healthy larvae	Parasitised larvae
1 ...	50	14	5	20	3	9	2	12	4
2 ...	50	22	3	26	1	21	1	18	2
3 ...	50	33	6	13	1	16	1	16	.
4 ...	50	28	6	12	1	13	4	17	...
5 ...	50	22	5	16	3	20	2	18	...
6 ...	50	23	8	19	10	26	6	16	7
7 ...	50	10	8	4	4	15	4	...	3
8 ...	50	8	16	...	...	...	...	...	...

N.B.—Plot D is an adjoining plot of a size of the same dimension as the experimental plot but intercepted with cajanus.

The introduced parasite was recovered from infested pods collected in plots A and B but not in C or D. But natural parasites were recovered from all the plots. It is clearly evident therefore, that both the natural parasite (Microbracon brevicornis) of the pod-borer larvæ and the introduced or released parasite Microbracon hebetor S., select out the same host separately in the same plot for parasitisation.

In one particular season during which there was continuous rainfall, the introduced parasites failed to establish themselves. There was no recovery of either the natural parasite or the introduced parasites indicating that particular adverse weather conditions have the same effect on both the natural and introduced parasite.

While the advantages of the work of the natural parasite and the releases of the other allied parasite is evident, it is to be admitted, that the fact of both these parasites preferring for their attack, only half to full-grown borer-caterpillars and rejecting the earlier younger stages, is a positive defect since these latter stages are fully at liberty to infect the pods and destory the internal beans especially of the younger pods. Whatever the destruction caused by the younger stages, it is left unchecked by the activities of these two parasites; to that extent the control effected inevitably becomes incomplete. However, the effective control of the half to fully mature caterpillars by these very parasites, should fairly compensate for the absence of parasite-efficiency against the earlier stages.

more especially because the greatest measure of damage and loss to the crop is inflicted by the extremely rapid and voracious feeding of the half to fully mature caterpillars and not the earlier younger ones.

Thanks are due to Sri P. R. Raghuram, Artist, who helped the authors in taking the several photographs and making line-drawings.

Reference :—

1. Hampson, G. F. ... Fauna of British India, Moths Vol II.
2. Krishnamurti, B. & Appanna, M. Microbracon brevicornis in the biological control of the Lab-Lab, pod-borer. Curr. Sci. May 1944. 13. 135.
3. Kunhikannan, K. ... 'Avare Kayannu koreyuva hula' (In Kannada) Department of Agriculture, Mysore, 1928.

EXPLANATION OF FIGURES.

PLATE 1.

Developmental Stages of the Lab-lab Pod Borer, Adisura atkinsoni, M.

1. Lab-lab pod showing the eggs of the pod-borer, and holes cut by the Larvæ.
2. Single Egg. (Enlarged).
3. 1st instar Larva (Enlarged)
4. 3rd instar Larva (Enlarged).
5. 6th instar Larva (Side view).
5a. 6th Instar Larva (Dorsal view).
6. Pupa (Ventral view).
6a. Pupa (Dorsal view).
7. Moth. Male.
7a. Moth. Female.

PLATE 2.

1. Lay-out of Lab-lab field at Central Farm, Hebbal where parasite releases were made.
2. Lay-out of Lab-lab plots at Central Farm, Hebbal where dusting experiments were conducted.

PLATE 3.

1. Photograph showing (A) Microbracon hebetor, S., Eggs on Adisura atkinsoni, M., larva; (B) Microbracon hebetor grubs on host larva.
2. Microbracon hebetor, S., Eggs. (Enlarged) on Adisura atkinsoni, M., larva.
3. Microbracon hebetor, S., Grubs (Enlarged) on Adisura atkinsoni, M., larva.
4. Microbracon hebetor, S., Pupa on Adisura atkinsoni larva.
5. Microbracon hebetor, S., Adult. Female.
6. Microbracon brevicornis, S. (Natural parasite of Adisura atkinsoni, M.) Adult. Female.

PLATE 4.

1. Microbracon hebetor, S., Grub. (Enlarged).
2. Microbracon hebetor, S., Pupa. (Enlarged). Cocoon cut open to show Pupa inside.

WD 2014—GPB—5,000—23-7-48

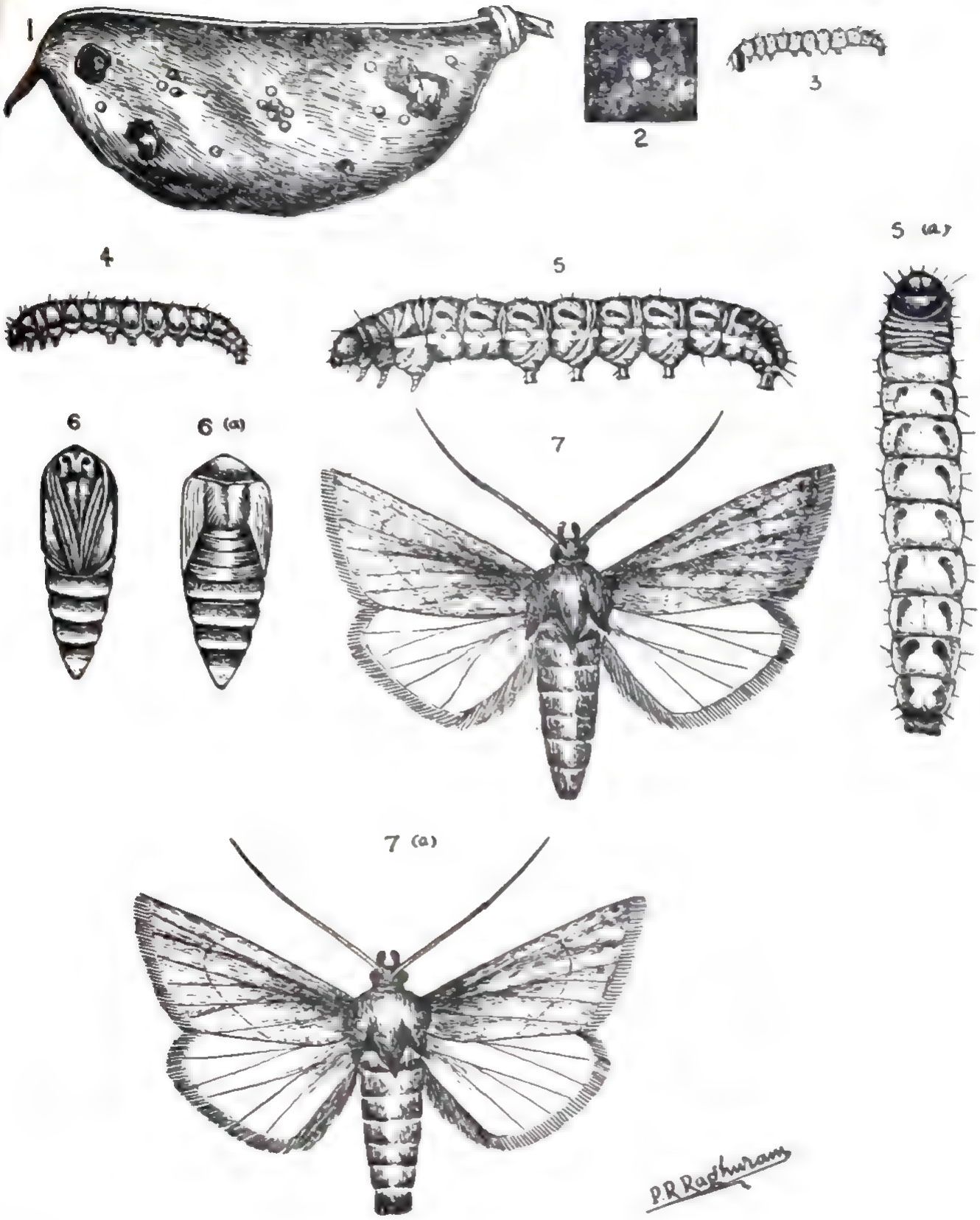

1
2
3
4
5
5 (a)
6
6 (a)
7
7 (a)
P R Raghuram

PLATE 2—(1).

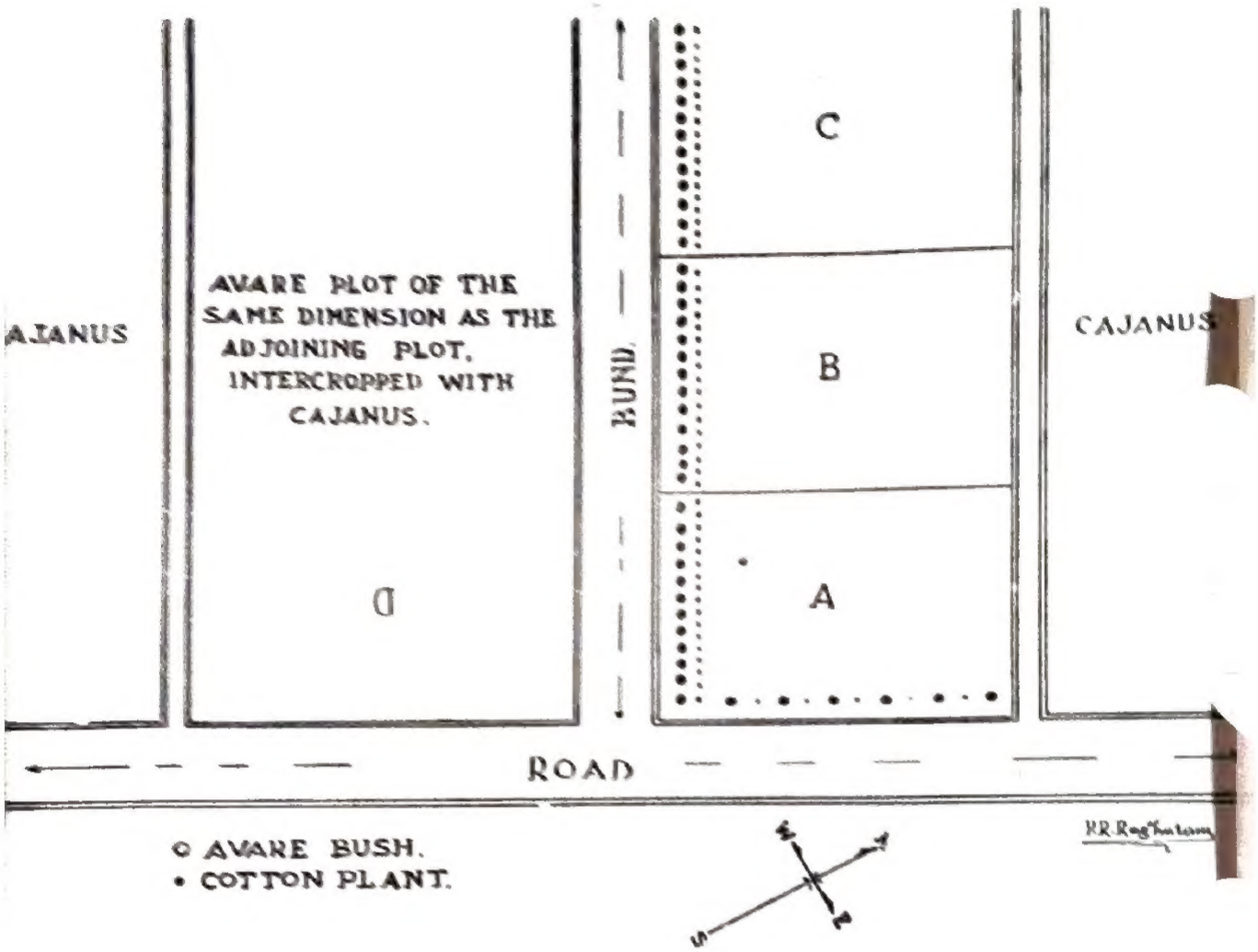
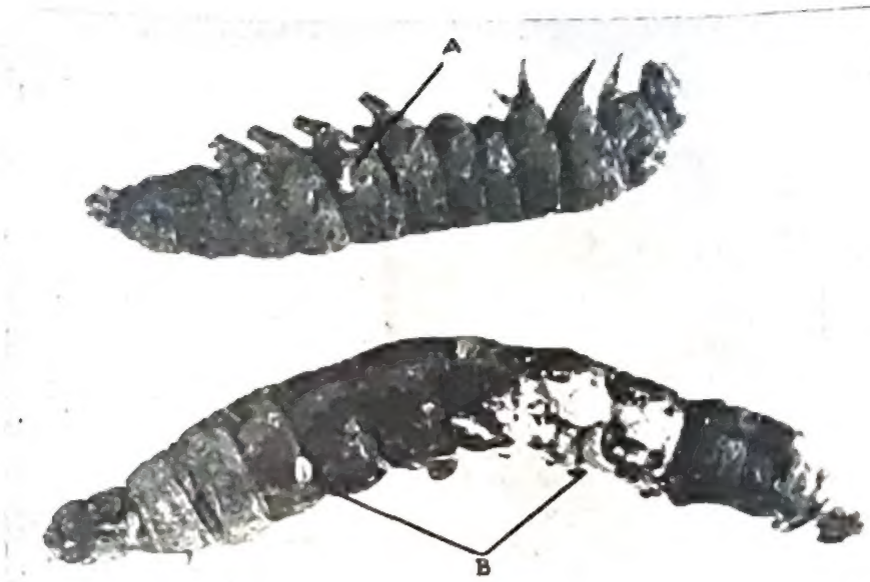
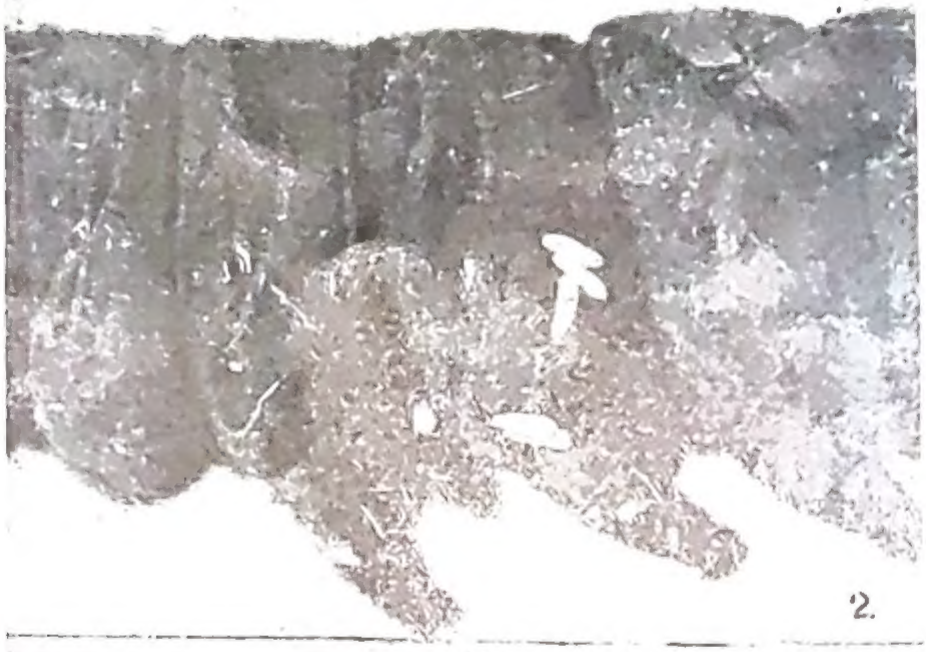


PLATE 2—(2).

G 9	C 8	D 7
D 4	G 5	C 6
C 3	D 2	G 1

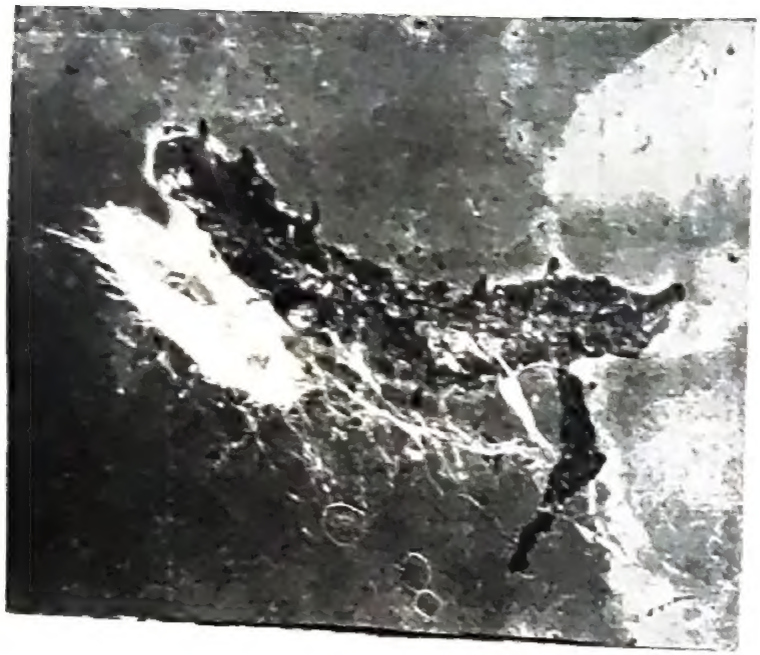


1



2.

3



5

6

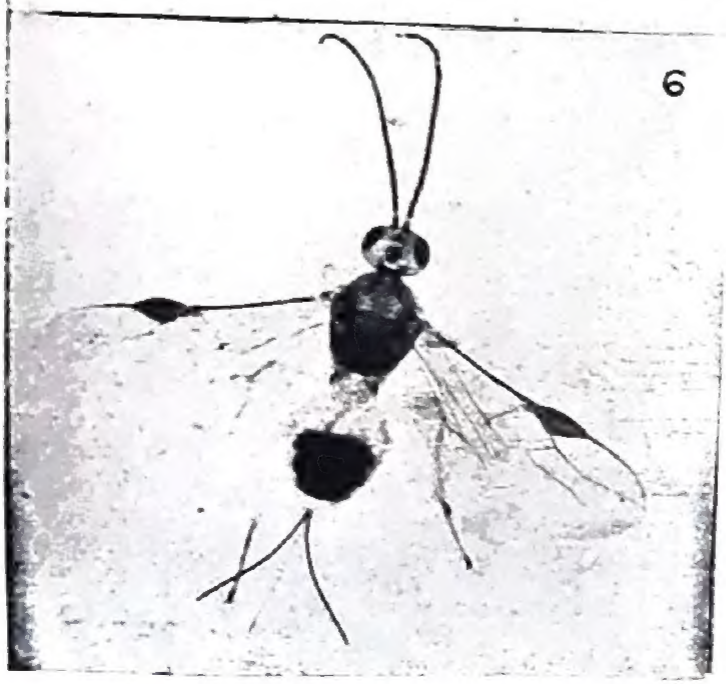


PLATE 4.